Small Business Innovation Research/Small Business Tech Transfer

Integrated MLI: Advanced Thermal Insulation Using Micro-Molding Technology, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

Current Multilayer Insulation (MLI) technology is over 50 years old, and is typically comprised of 10 to 120 layers of metalized polymer films separated by polyester netting. MLI is the best thermal insulation in a vacuum, and is the insulation of choice for spacecraft and cryogenic system insulation, but has problems relating to density control and performance, application labor, and difficulty covering small and large scales. An innovative concept for improved cryogenic insulation, Integrated MLI, is proposed based on a micro-machined or micro-molded substructure. Thermal conductivity will be lower than conventional MLI, layers would be inherently attached to each other and support one another, construction would be easier, and the vacuum shell could be supported by the IMLI, greatly reducing the mass of the insulation system with vacuum shells used to insulate cryogenic dewars or tanks. An improved insulation should provide lower thermal conductivity, lower specific thermal conductivity, vacuum compatibility, layers inherently attached to each other that support themselves, efficient assembly and provide structural reliability. Recent advances in injection molding has resulted in the ability to mold structures with very small features, comprised of materials with low thermal conductivity and low outgassing. Integrated MLI will consist of small micro-machined or micro-molded structures that support radiation barrier layers, and will offer significant advantages. Preliminary analysis of several potential designs indicates IMLI has a theoretical thermal conductivity less than half that of MLI, allowing improved long term cryogenic propellant storage and spacecraft thermal performance. It may provide improved structural assembly, strength and integrity over current MLI. This proposal is to work on the design, material selection, assembly processes and preliminary physical property testing of a prototype of this innovative new thermal insulation.

Anticipated Benefits

Extremely efficient thermal insulation, easily assembled and applied to cover various surfaces, would have utility in commercial cryogenic applications such as cryogenic vessels and pipes in scientific and industrial applications. A major use would be insulating dewars for liquid nitrogen, liquid helium, liquid oxygen, etc., which are widely found in research and industrial uses. Other potential applications include large commercial tanks, industrial boilers and industrial hot and cold process equipment, refrigerated trucks and trailers, insulated tank, container and rail cars, liquid hydrogen fueled aircraft or fuel cells, appliances such as refrigerators and freezers, hot water heaters, Thermos type liquid containers, picnic and mobile containers to keep foods hot or cold, marine refrigeration, potentially even house structures. Integrated MLI might provide improved thermal performance and have improved structural integrity for spacecraft cryogenic propellant storage and thermal insulation. Other standard spacecraft insulation uses, such as insulating instruments, or insulating and preserving liquid hydrogen or liquid oxygen cryogenic systems and dewars, might also be well served by IMLI. IMLI could provide the

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

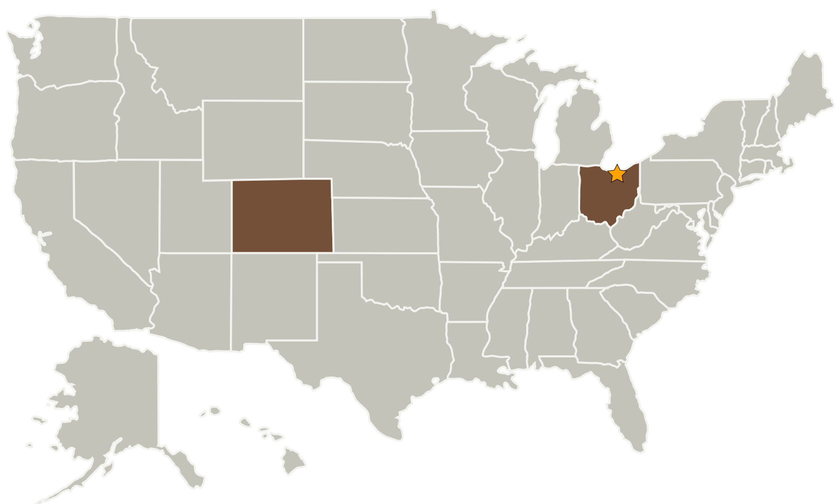
Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer cryogenic insulation and vacuum shell used to insulation and maintain cryogenics on space instruments, satellites, CEV/CLV spacecraft cabins and lunar surface habitats. It may be able to provide substantially longer term cryogenic storage, helping enable longer term manned space flights. Low mass, low thermal conductance cryotank structural systems are of interest to NASA. IMLI may have excellent properties required for spacecraft use; low thermal conductance, vacuum compatibility of materials, inherent control of layer dimensions and density, self-supporting layers with a post-and-beam substructure, ease of assembly for small and large areas, potential for both tight seams and material flexibility.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
Quest Product Development Corporation	Supporting Organization	Industry	Arvada, Colorado
Quest Thermal Group	Supporting Organization	Industry	Arvada, Colorado

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

David W Plachta

Principal Investigator:

Scott Dye

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - └ TX14.1 Cryogenic Systems
    - └ TX14.1.1 In-space Propellant Storage & Utilization

Primary U.S. Work Locations	
Colorado	Ohio